

Stock Market Responses to Fed Funds Rate Changes

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Abstract

Proponents of the semi-strong form of the Efficient Market Hypothesis argue that stock prices fully reflect all publicly available information. Furthermore, economic models assume that investors rationally evaluate future market performance and that there is no systematic bias in investor expectations. This paper empirically evaluates these hypotheses in the context of stock market response following the FOMC's announcements on the target fed funds rate. In particular, the paper shows that investors systematically underestimate stock market response to the fed funds rate changes, which creates profitable arbitrage opportunities.

Keywords: Fed funds rate; market efficiency; event studies.

1. Introduction

In his well-publicized speech to the American Enterprise Institute on December 5, 1996, the former Federal Reserve Bank (Fed) Chairman Alan Greenspan [1] used the term "irrational exuberance" to describe the behavior of stock markets and the rapid appreciation of financial assets. While economic theory does not preclude the possibility of asset-price bubbles, the semi-strong form of the efficient market hypothesis predicts that one cannot consistently make above normal, long run economic profits in such markets using public information and historic price data [2-4]. In this paper, we test the predictions of this hypothesis by analyzing stock market responses to the Fed's announcements of the target fed funds rate changes.

There are several reasons to focus the analysis on the fed funds rate changes. First, earlier research on Fed's policy changes conducted by Waud [5] suggests that a decrease in a discount rate positively affects the stock market while an increase in a discount rate negatively affects the stock market. Transparency rules at the Fed have changed since Waud's study, and the market's response to the Fed's announcements might have changed. Furthermore, a change in the fed funds rate is expected to have a more direct implication for stock markets rather than a change in the discount rate because of the stigma associated with using the Fed's discount window. Second, the fed funds rate is one of the most closely watched economic variables. Third, the Federal Open Market Committee (FOMC) heavily relies on data from publicly available sources, such as the Conference Board, the Bureau of Labor and Statistics, and the Bureau of Economic Analysis, in its decision-making process. Further, the FOMC minutes are publicly available. Fourth, plausible interest rate change scenarios are highly scrutinized by economic and financial experts prior to the FOMC meetings. Fifth, the fed funds rate changes are predictable to a degree. Sixth, the FOMC could be reluctant to make sharp changes in the target fed funds rate in order to avoid turmoil in financial markets. In addition, the Fed Chairman often signals the Fed's future policy options and decisions prior to the FOMC meetings.

All of the above-described reasons suggest that investors should have sufficient information to make rational predictions regarding the fed funds rate changes and to incorporate these predictions in their trading decisions. Furthermore, according to the efficient market hypothesis, investors should not be able to make above normal economic profits in the long run by using simple trading strategies. We argue that this inability does not necessarily exist. Specifically, we show that a simple strategy of buying stocks a day prior to the announced FOMC meeting and reselling the stocks post-announcement consistently delivers above-normal profits. Furthermore, the profit levels following this strategy have averaged five to nine times the normal economic profits during the period tested.

2. Methods

The FOMC meets eight times a year at scheduled times that are widely publicized. In addition, when the occasion warrants, the FOMC has unscheduled meetings without notifying the public prior to the meeting. The data on meeting dates and the federal

funds target rate were obtained from the Federal Reserve's web site [6]. Prior to 1994, the transparency rules in the Federal Reserve Bank were different and the FOMC did not immediately announce its policy changes following the FOMC meetings as it does today [7, 8]. Therefore, we analyze only the data beginning in 1994. We also collected data on the daily closing prices for the Dow Jones Industrial Average Index (DJIA), the Standard & Poor's 500 Index (S&P 500), and the National Association of Securities Dealers Automated Quotations Composite Index (NASDAQ) from January 1, 1994 to April 15, 2010. For our purposes, we will differentiate between FOMC announcements after scheduled meetings and those that occurred after unscheduled meetings. There were 113 FOMC announcements after scheduled meetings. Of these, 28 announced rate increases, 23 announced rate decreases and 87 announced no change in rates. There were 18 unscheduled FOMC meetings. After 6 of these, the FOMC decreased the fed funds target rate; after 12 of them, they kept the target rate constant. The FOMC did not raise its target rate at any of the unscheduled meetings. Because prior information regarding unscheduled FOMC meetings may not be publicly available, we restrict our attention to stock market response to only *scheduled* FOMC meetings in order to test semi-strong market efficiency.

Table 1: Summary Statistics.

Variable	Obs.	Mean	Std. Dev.	Min	Max
DJIA	4354	8779.9	2812.97	3242.0	14164.5
S&P500	4354	1018.0	322.91	429.1	1565.2
Nasdaq	4354	1858.7	783.42	645.9	5048.6
<i>All Meetings:</i>					
Fed funds rate	156	3.641	1.943	0.125	6.5
Δ fed funds rate	156	-0.023	0.239	-0.875	0.75
<i>Scheduled Meetings:</i>					
Fed funds rate	138	3.693	1.949	0.125	6.5
Δ fed funds rate	138	-0.005	0.231	-0.875	0.75

The summary statistics for the data are presented in Table 1. Table 2 presents the daily returns of the three stock market indices. The daily percentage returns are calculated as percentage changes in closing prices. Note that the mean percentage daily returns during scheduled FOMC announcement days are five to nine times higher than the mean daily returns for all days in the entire period of analysis. For example, DJIA rises by about 0.035% during the average day in the period and by about 0.3% during the scheduled FOMC announcement days. On the other hand, the standard deviations of daily percentage returns on scheduled meeting days are no higher than the standard deviations of daily percentage returns on regular days.

Table 2: Daily Percentage Returns for DJIA, S&P500, and NASDAQ.

Variable	Obs.	Mean	Std. Dev.	Min	Max
Δ DJIA	4353	0.00035	0.01157	-0.07873	0.11080
Δ S&P500	4353	0.00031	0.01215	-0.09035	0.11580
Δ NASDAQ	4353	0.00044	0.01655	-0.09669	0.14173
<i>Scheduled Announcement Days:</i>					
Δ DJIA	138	0.00306	0.01068	-0.02426	0.04199
Δ S&P500	138	0.00383	0.01169	-0.02527	0.05136
Δ NASDAQ	138	0.00499	0.01593	-0.04804	0.07874

3. Results

We use two-tailed t-tests with equal variances to compare the daily percentage returns on scheduled announcement days to the daily percentage returns on regular days (since we could not reject the hypothesis of equal variances using the F-test). If traders are rational and markets are efficient, the returns on announcement days should not be significantly higher than average daily returns during the period. The results presented in Table 3 indicate that daily market returns are statistically higher at the 1% significance level on the FOMC announcement days for all three indices.

Table 3: Tests of Differences in Average Daily Return.

	Difference	Std. Err.	T	P-value
DJIA	0.00271	0.00100	2.716***	0.0066
S&P500	0.00353	0.00105	3.359***	0.0008
NASDAQ	0.00455	0.00143	3.187***	0.0014

* – $p < 0.1$, ** – $p < 0.05$, *** – $p < 0.01$

Stock market response may vary depending on the direction of the fed funds rate change. Thus, the data on the scheduled FOMC meeting announcement day returns are partitioned into those days announcing a rate increase (28 observations), those announcing a rate decrease (23 observations), and those announcing no rate change (87 observations). If traders are rational, the stock market should reflect rate change expectations, and we should not observe a systematic bias in stock market movements that depend upon the direction of change announced by the FOMC. The results of tests of daily stock market returns conditioned by the direction of change are presented in Table 4.

Although all the indices show a positive bias regardless of the direction of rate change, only when the FOMC held rates constant did the changes in the S&P and NASDAQ show statistically higher returns. Because the number of observations with rate increases and the number with rate decreases are relatively small, it is not too surprising to find results of no significance in those cases. Interestingly, the positive bias of returns on days after meetings in which the FOMC raises interest rates contrasts with the findings reported by Waud [5] that the stock market tends to decrease following a rate increase.

Table 4: Tests of Differences in Average Daily Percentage Return Conditional on FOMC Announcements.

	Difference	Std. Err.	T	P-value
Rate Increase:				
DJIA	0.00300	0.00219	1.370	0.1707
S&P500	0.00354	0.00230	1.539	0.1240
NASDAQ	0.00530	0.00313	1.691*	0.0908
No Rate Change:				
DJIA	0.00255	0.00125	2.041**	0.0413
S&P500	0.00336	0.00131	2.560**	0.0105
NASDAQ	0.00432	0.00179	2.414**	0.0158
Rate Decrease:				
DJIA	0.00297	0.00242	1.224	0.2212
S&P500	0.00414	0.00255	1.624	0.1044
NASDAQ	0.00454	0.00347	1.310	0.1902

* – $p < 0.1$, ** – $p < 0.05$, *** – $p < 0.01$

We also performed the above-mentioned tests using logarithmic price changes. The results are qualitatively identical to those obtained with percentage price changes because a logarithmic difference approximates the growth rate for small percentage changes.

Some studies suggest that the stock market may lag several days before it fully reflects the weight of new information [9]. To investigate this issue, we calculated 2-day, 3-day, 4-day, and 5-day cumulative returns following the scheduled FOMC meetings. These n-day cumulative returns are then compared to the mean n-day cumulative returns in the period. The test results are presented in Tables 5 and 6. The 2-day market returns following the FOMC announcements are significantly higher than regular 2-day returns for the three indices at the 5 percent level. The 3-day and 4-day returns are significant at the 5 percent level for S&P 500 and NASDAQ. The 5-day returns following the announced FOMC meetings are not statistically different at the 5 percent level from comparable normal returns for any of the indices.

Figure 1 below describes the one-day through five-day cumulative return differences for the three indices. For all three indices, the bulk of the returns occur in the first two days following a FOMC meeting. After that, the cumulative returns cease to rise significantly indicating that returns become largely normal again (at least out to five days). The lone exception to this pattern is that the NASDAQ, which seems to have marked below market returns after the fourth day following a meeting.

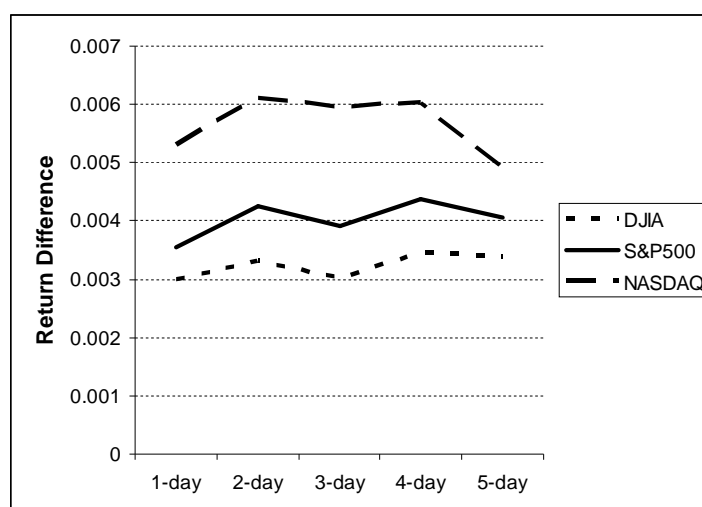
Table 5: Risk-Return Comparison of Cumulative Returns Following an FOMC Meeting.

	Cumulative Returns			Standard Deviation	
	FOMC anno. Days	All Days	Difference	FOMC anno. Days	All Days
DJIA:					
1-day	0.00306	0.00035	0.00271	0.01068	0.01157
2-day	0.00399	0.00068	0.00330	0.01432	0.01587
3-day	0.00404	0.00101	0.00302	0.01671	0.01881
4-day	0.00481	0.00135	0.00346	0.01949	0.02155
5-day	0.00506	0.00168	0.00338	0.02065	0.02393
S&P500:					
1-day	0.00383	0.00031	0.00353	0.01169	0.01215
2-day	0.00487	0.00061	0.00426	0.01499	0.01659
3-day	0.00481	0.00090	0.00391	0.01711	0.01960
4-day	0.00557	0.00119	0.00438	0.01992	0.02235
5-day	0.00555	0.00148	0.00407	0.02213	0.02471
Nasdaq:					
1-day	0.00499	0.00044	0.00455	0.01593	0.01655
2-day	0.00699	0.00087	0.00611	0.02334	0.02318
3-day	0.00725	0.00129	0.00596	0.02551	0.02766
4-day	0.00773	0.00171	0.00603	0.02871	0.03174
5-day	0.00705	0.00212	0.00492	0.03613	0.03532

Table 6: Tests of Two- to Five-Day Cumulative Return Differences.

	Difference	Std. Err.	t	P-value
DJIA:				
2-day	0.00330	0.00137	2.415**	0.0158
3-day	0.00302	0.00162	1.865*	0.0622
4-day	0.00346	0.00186	1.862*	0.0627
5-day	0.00338	0.00206	1.639	0.1013
S&P500:				
2-day	0.00426	0.00143	2.978***	0.0029
3-day	0.00391	0.00169	2.314**	0.0207
4-day	0.00438	0.00193	2.273**	0.0231
5-day	0.00407	0.00213	1.909*	0.0564
NASDAQ:				
2-day	0.00611	0.00201	3.050***	0.0023
3-day	0.00596	0.00239	2.499**	0.0125
4-day	0.00603	0.00274	2.203**	0.0276
5-day	0.00492	0.00306	1.610	0.1075

* – p<0.1, ** – p<0.05, *** – p<0.01

Figure 1: Comparison of 1-Day through 5-Day Cumulative Returns following the Scheduled FOMC Meeting Days with Other Days.

One aspect of these findings worthy of note is that the standard deviation of returns in all cases is not substantially greater (and, in most cases, is at least slightly less) when compared to the corresponding average standard deviation of the market in general. Thus, an investor who buys an index at the closing price the day before a FOMC announcement and sells at the closing price a day or two later assumes no greater than average risk.

One plausible explanation for the above-normal returns following the rate change announcements is that traders become extremely risk averse or pessimistic right before the uncertainty is resolved by the FOMC announcement. If this explanation is valid, one should observe a decline in stock market returns (as compared to regular day returns) prior to the scheduled FOMC meetings. To test the validity of this hypothesis, we compared the daily stock market returns for the one through five trading day periods prior to the scheduled FOMC meetings with the relevant regular trading day returns. There appears to be no consistent discernable pattern of excess returns on days prior to meetings. Further, on no day did excess returns achieve statistical significance. Table 7 presents our findings.

Table 7: Comparison of Average Daily Stock Market Returns Prior to the Fed Funds Rate Announcements to Average Trading Day Stock Market Returns.

	Difference	Std. Err.	t	P-value
DJIA:				
1-day	0.00186	0.00101	1.842*	0.0655
2-day	0.00021	0.00100	0.215	0.8296
3-day	-0.00124	0.00100	-1.243	0.2139
4-day	0.00008	0.00100	0.080	0.9360
5-day	-0.00133	0.00100	-1.327	0.1845
S&P500:				
1-day	0.00154	0.00106	1.461	0.1440
2-day	-0.00026	0.00104	-0.244	0.8071
3-day	-0.00101	0.00105	-0.958	0.3380
4-day	0.00013	0.00105	0.122	0.9032
5-day	-0.00115	0.00105	-1.096	0.2733
NASDAQ:				
1-day	0.00027	0.00143	0.187	0.8517
2-day	-0.00093	0.00142	-0.654	0.5132
3-day	-0.00138	0.00143	-0.966	0.3340
4-day	-0.00167	0.00143	-1.170	0.2421
5-day	-0.00134	0.00143	-0.940	0.3475

4. Discussion

One caveat that is frequently made in studies of market efficiency is that one cannot simply buy an index. Moreover, many open-ended index funds discourage frequent trading that might be required to exercise the short-term strategy that we suggest. Over the past decade, however, a number of Exchange Traded Funds (ETFs) have emerged designed to allow these frequent trades. One of the oldest (if not the oldest) of these is the iShares S&P Fund (trading symbol IVV). We performed similar tests of efficiency of the market after FOMC announcements on IVV to those we did with the S&P Index. We used daily data from IVV's inception on May 15, 2000 until April 15, 2010. The relevant results of our tests can be found in Tables 8 and 9.

Table 8: Comparison of Returns on IVV and Returns on S&P 500 over the Same Time Horizon.

	n-day cumulative returns on IVV following FOMC scheduled days			n-day cumulative returns on S&P500 on all days		
	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.
Day 1	79	0.00419	0.01342	2490	-0.00007	0.01378
Day 2	79	0.00507	0.01864	2490	-0.00014	0.01858
Day 3	79	0.00434	0.01902	2490	-0.00022	0.02171
Day 4	79	0.00309	0.02242	2490	-0.00030	0.02488
Day 5	79	0.00295	0.02603	2490	-0.00037	0.02757

Again, statistically significant, above-average returns exist if one buys at the closing price the day before a FOMC announcement and sells at the closing price a day or two later. Also, market risk (as measured by the standard deviation of returns) on days of or just following FOMC announcements is comparable to or slightly less than average when compared to the risk of the overall market.

Table 9: Test of Cumulative Return Differences.

	Return Difference (IVV return – S&P500 return)	Std. Err.	t	P-value
1-day	0.00426	0.00157	2.707***	0.0068
2-day	0.00521	0.00212	2.455**	0.0142
3-day	0.00456	0.00247	1.843*	0.0654
4-day	0.00339	0.00284	1.196	0.2319
5-day	0.00332	0.00315	1.056	0.2910

* – $p < 0.1$, ** – $p < 0.05$, *** – $p < 0.01$

To give some perspective on the extent of the gains, we assume an investor has \$10,000 to invest pursuing a one-day strategy. That is, we assume he can buy IVV at the closing price the day before a scheduled FOMC announcement and sell at the closing price one day later. Although trading costs existed in the past, Fidelity Investments has recently announced that many of the iShares ETFs, including IVV, can be traded online with no brokerage fee [10]. Even though we are back testing the strategy, our purpose is forward-looking. We, therefore, will ignore transactions costs. That said, for each FOMC announcement day, the one-day strategy earned on average over 4 tenths of one percent (or \$42.60 given the \$10,000 investment) in above normal market returns. Over the 10-year life of IVV, the total gain of the strategy totaled \$3365 in excess market returns, a considerable proportion of the original investment.

5. Conclusion

The semi-strong form of market efficiency postulates that one cannot consistently make above-normal profits in the stock market by using public information. Our findings, on the other hand, indicate that stock markets rise more than expectations warrant during the days of scheduled FOMC meetings. This result is surprising because one should not expect a systematic bias in stock market movements on these days. The fed funds target rate changes are highly predictable and one would expect that investors would rationally incorporate expected rate changes in their trading decisions. Furthermore, the above-normal returns following the

scheduled FOMC meetings remain for at least two days, but disappear over time. One might argue that the higher average return comes only at the expense of increased risk. This argument is not supported here because our results indicate that the standard deviation of stock price changes is not greater on scheduled FOMC announcement days. Our results then indicate that markets overreact to policy days following FOMC announcements in such a way as investors may easily exploit.

Competing Interests

The authors declare that they have no competing interests.

Authors' Contributions

NA developed the framework, collected the data, carried out the statistical analysis and drafted the manuscript. LH further developed the framework, expanded the data set, wrote section 4 and edited the manuscript. NF collected the data on Fed's policy actions and completed preliminary estimates.

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